FOOD SOURCES AND FEEDING BEHAVIOUR OF STRIATED CARACARAS (*PHALCOBOENUS AUSTRALIS*) IN WINTER ON AN UNINHABITED ISLAND IN THE FALKLAND ISLANDS: FEEDING FRENZY OR PEACEABLE COMMUNAL MEAL TIMES?

Las fuentes de alimento del carancho negro (*Phalcoboenus australis*) en una isla deshabitada de las islas Malvinas en invierno: Festín frenético o comidas comunitarias pacíficas?

ROBIN WOODS[1], JONATHAN MEIBURG[2] & DAVID GALLOWAY[3]

[1]68 Aller Park Road, Newton Abbott, TQ12 4NQ, UK.
[2]27 Grace Court, Brooklyn, NY 11201, USA.
[3]School of Education, Durham University, DH1 1TA, UK.

Correspondencia: David Galloway, d.m.galloway@durham.ac.uk

ABSTRACT.- Little is known about the diet of Striated Caracaras (*Phalcoboenus australis*) in the Falkland Islands in winter, when breeding seabird colonies are absent. Opportunistic observations were made on Steeple Jason Island of feeding events on carrion or recently dead avian prey, and systematic observations of Striated Caracaras raking the soil for invertebrates. In the absence of summer food sources, this species appears to rely on communal, sociable raking for invertebrates. This behaviour contrasts with the "feeding frenzy" when fresh meat is available. Discussion focusses on the survival value of this social foraging behaviour.
KEYWORDS.- Falkland Islands, food sources, *Phalcoboenus australis*, winter.

RESUMEN.- Poco se sabe sobre la dieta del carancho negro (*Phalcoboenus australis*) en las islas Malvinas durante el invierno, cuando las colonias reproductivas de aves marinas están ausentes. Se realizaron observaciones sobre eventos de alimentación oportunista sobre carroña o sobre aves recién muertas, y observaciones sistemáticas cuando escarbaban el suelo buscando invertebrados. En ausencia de fuentes de alimentación de verano, esta especie parece alternar con el escarbado comunitario y sociable en busca de invertebrados. Este comportamiento contrasta con el "festín frenético" cuando hay carne fresca disponible. La discusión se centra en el valor de sobrevivencia de este comportamiento social.
PALABRAS CLAVE.- Fuentes alimentarias, invierno, islas Malvinas, *Phalcoboenus australis*.

Manuscrito recibido el 22 de junio de 2017, aceptado el 02 de noviembre de 2017.

INTRODUCTION

Striated Caracaras (*Phalcoboenus australis*) are the rarest and most restricted in range of the caracaras, a group of versatile, scavenging raptors that occur almost entirely in South America. During his visits to the Falkland Islands in 1833–4, Darwin (2003) described them as remarkably fearless and tame. Striated Caracaras are the southernmost of the four *Phalcoboenus* caracaras; the other three species occur in alpine zones of the Andes. Striated Caracaras are found on the seacoasts of exposed islands in the south and west of Fuego–Patagonia (including Cape Horn), Isla de los Estados (Staten Island), and the Falkland Islands, where they are known locally as "Johnny rooks". They breed in association with colonial seabirds, and they often occur near colonies of pinnipeds. With an estimated global population of 1,500 to 4,000 individuals (BirdLife International 2015) and a restricted range they are classified as Near–Threatened

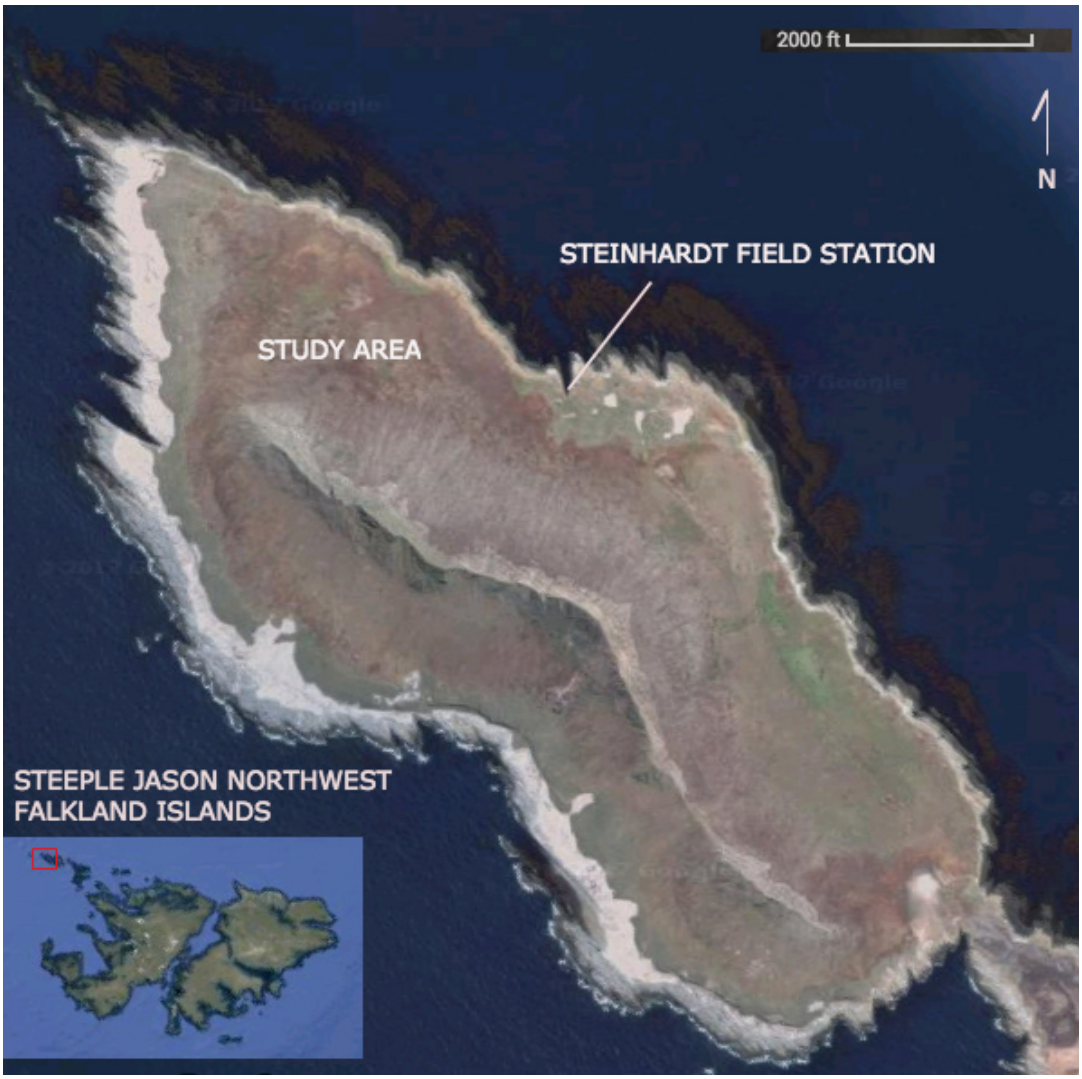

Figure 1. Steeple Jason Island: Study area map.

by the IUCN.

This paper reports research on the diet of Striated Caracaras in winter on an uninhabited island and their behaviour while feeding. The main summer food sources of this raptor are seabird colonies (Woods and Woods 2006). When these are absent Rexer–Huber & Bildstein (2012) suggested that farm settlements might provide significant alternative food sources. They noted ravenous and competitive feeding behaviour in winter near farm settlements on two outlying islands. While acknowledging the limitations of pellet data (Duffy & Jackson 1986, Mersmann *et al*. 1992) Rexer–Huber and Bildstein's analysis of pellets from a communal roost near the settlement on Saunders Island identified plant material, marine and terrestrial invertebrates, and mammal remains among 53 categories of items. Goose feathers occurred in most pellets: Upland Goose (*Chloephaga picta*) and Ruddy–headed Goose (*C. rubidiceps*) in 52.2% and 47.8%, respectively, and evidence of sheep in 26.9% of the pellets. However, the authors did not see Striated Caracaras approach a live goose or attempt to kill one; they fed on geese that had died naturally and when geese were fed to farm animals or were killed by Variable Hawks (*Geranoaetus polyosoma*).

Saunders Island did not appear to support breeding pairs of Striated Caracaras and the individuals observed were mostly juveniles or sub–adults. We traced no reports that include the winter diet of adult birds. Saunders Island did not support significant stands of Tussac grass (*Poa flabellata*); the breeding success of this species may depend on the presence of Tussac grass on undisturbed islands (Woods 2017). There would be no sheep carcasses or mutton scraps on these islands, nor would geese carcasses be available from being fed to farm animals. In the absence of any nutritional subsidy from human occupation we aimed to determine: (a) what avian or mamma-

lian prey would be available in winter on an uninhabited island; (b) what other naturally occurring food sources might be available.

MATERIALS AND METHODS

Location of fieldwork

We collected data on Steeple Jason Island, in the extreme northwest of the Falkland Islands, (5°02'15"S; 61°12'35"W, Fig. 1) from 10th August to 6th September 2012. With an area of 8.72 km^2, this island had never had permanent human habitation and the only significant building was the Wildlife Conservation Society's Steinhardt research station, used by visiting researchers (Fig. 1). Though stocked with sheep until 1965, the island still supported dense stands of Tussac grass and the world's largest colony of Black–browed Albatross (*Thalassarche melanophris*), as well as breeding populations of Rockhopper Penguins (*Eudyptes chrysocome*), Magellanic Penguins (*Spheniscus magellanicus*), Gentoo Penguins (*Pygoscelis papua*), Southern Giant Petrels (*Macronectes giganteus*), and Wilson's Storm Petrels (*Oceanites oceanicus*). In a 2006 survey Steeple Jason held 63 Striated Caracaras breeding pairs, making it one of the most populous breeding islands in the Falklands (Woods 2007a). During our visit the Striated Caracaras' main summer food sources from the breeding colonies of seabirds were absent, though Gentoo Penguins returned to land to roost. Elephant seals (*Mirounga leonina*) were also absent, though some sea lions (*Otaria flavescens*) and fur seals (*Arctocephalus australis*) remained.

Avian or mammalian prey as food sources.

Most of each day was spent in the field and we noted incidents as they occurred. We were assisted in this by a team from Falklands Conservation studying aspects of mouse biology on the island.

Other food sources and Striated Caracara behaviour while behaviour in the peaty subsoil

In preliminary observations, groups of 2 to 50 Striated Caracaras were seen using their talons to rake the topsoil consisting of decomposed Tussac and grass fragments below a layer of Sheep's sorrel (*Rumex acetosella*), apparently searching for invertebrates. Raking created areas largely free of surface vegetation, giving the appearance of a harrowed or lightly ploughed field. The largest of such areas measured approximately 75m x 25m and was visible on a satellite image (Fig. 1). There were numerous smaller raked areas. The birds appeared relaxed and were often closely accompanied by Blackish Cinclodes (*Cinclodes antarcticus*) (Fig. 2) and Austral Thrushes (*Turdus falcklandii*), which sifted through the clumps of peat the caracaras disturbed. Although it was known that invertebrates formed part of the Striated Caracaras' diet (Rexer–Huber & Bildstein 2012), there had not been any systematic study of this behaviour.

To evaluate behaviour, we constructed a sheet that included date, time, location on island, identity of bird (if banded), age (Striated Caracaras moult into their adult plumage in their fourth year, enabling distinction

Figure 2. Striated Caracaras raking for soil invertebrates, watched by Blackish Cinclodes.

between first winter, sub–adult and adult birds), number of "rakes" (times the bird raked the ground with its talons), number of feeding episodes observed, and other information (type of food taken, movements or interactions with other caracaras). We made 130 observations of Striated Caracaras raking the peaty subsoil for invertebrates. Of these, 122 lasted for an arbitrary criterion of 2 min and were used in the analyses. Statistical tests used to compare sub–groups, for example, feeding success of birds of different age groups, were one–way ANOVA and Chi square (Hoel 1966).

The age distribution of the birds observed compared reasonably well with that in an overall population estimate (Woods 2017): 58.2% adults (54.3% in the population estimate); 13.9% sub–adults (13.3%); 27.9% first winter birds (32.4%). Forty–one of 122 observations were of 29 individually–banded birds.

To further study behaviour while feeding we made nine detailed observations of groups of Striated Caracaras foraging for invertebrates and of interactions between individuals. We started with a target group of between two and seven caracaras while feeding and observations lasted from less than 5 to 22 min, during which we recorded information on social interactions. We noted all changes in behaviour or activity, until they had dispersed or joined a larger group where it was no longer possible to identify individuals.

RESULTS

Opportunistic feeding on live or dead avian or mammalian prey

We recorded only three feeding events in four weeks:

(a) A noisy group of about 35 Striated Caracaras were seen attacking a recently dead goose in a "feeding frenzy," in which each individual fought for its share of food. Within 7 min, the corpse was stripped and one of Steeple Jason's few resident Southern Caracaras (*Caracara plancus*) flew off with the goose's vertebrae. We had seen similar behaviour during banding sessions when groups of at least 20 birds were attracted by a leg of mutton staked to the ground. In the first session, they were so absorbed by the struggle for food that we caught three by hand before they became snared.

(b) Striated Caracaras were seen feeding on two dead Gentoo Penguins, possibly killed by the caracaras but, like the goose, predation was not confirmed.

(c) A dead sea lion previously covered by kelp was uncovered by heavy seas breaking on the shore on 3rd September. When first seen at 17:30 hrs 27 Striated Caracaras were feeding on the carcass. By dusk, 21 were present. At 20:30, when the light had almost gone, 10 were still feeding. At 09:07 the following morning 45 caracaras were present. At least 15 were clambering over the carcass, but others were standing and waiting nearby, many with full or partially full crops. By 16:00 on the second day 50 caracaras were still present, but an hour later – nearly 48 hours after the carcass was first seen – 13 were present, but only two were feeding.

We did not see caracaras feeding on seal feces, we saw individuals with unmistakeable traces of feces on their bills and legs.

Other food sources and Striated Caracara behaviour while raking in the peaty subsoil

Apart from a small number of spiders, all feeding events recorded from 120 observations of Striated Caracaras raking the subsoil were either small earthworms or beetle larvae. Separately, we collected 127 larvae (total weight 16.2 g; mean per larva: 0.1275 g) and 80 worms (total weight 14.7 g; mean per worm: 0.1837 g).

Within each 2–min observation the number of rakes ranged from 35 to 134 (mean: 80.44; SD: 21.70,) and the number of feeding events from 0 to 14 (mean: 5.30; SD: 3.19).

There were no significant differences between the number of rakes by adults, sub–adults and first winter birds ($F = 0.107$; $p < 0.898$) nor between the number of recorded feeds ($F = 2.49$; $p < 0.087$). We also looked at the number of rakes per feed (mean: 24.22), but again, there was no significant difference between the three age groups ($F = 1.9$; $p < 0.155$).

Raking behaviour was also observed in rotting kelp on the shoreline, but usually only by individual birds or pairs, and in far lower numbers than inland. The density of food appeared to be higher in rotting kelp than in peat soil. One adult with a full crop was observed taking numerous larvae from an excavated cavity with a much higher "success rate" in terms of prey collected than recorded for any individuals raking the soil.

Five issues emerged from the field notes on groups of Striated Caracaras foraging for invertebrates:

(1) In contrast to behaviour on finding a new source of red meat, birds were generally quiet; there was little contact or alarm calling with the exception of occasional incidents when a territorial bird swooped in and attacked a group.

(2) Adults in a group could also defend the area on which they were raking; the attack was seldom prolonged and usually the birds resumed feeding in reasonably close proximity. For example, our description of two first winter birds was:

Adult with half crop joins group at 1 min 15 s. No

apparent protest. Another adult joins the group at 1 min 45 s. All 4 birds raking and feeding together. A sub–adult flies in and attempts to join the group; a vigorous fight ensues in which the birds hold this intruder down on the ground with their claws for 20–30 s. The sub–adult retreats, but remains within 15 m of the group. A new first winter bird flies in without resistance.

(3) The groups were fluid, with birds arriving and departing, usually with no evidence of aggressive interactions.

(4) Birds were observed raking and feeding together in the same hole in the peat, heads nearly touching, with no apparent aggression. On two occasions, we observed first winter birds taking food peaceably from each other's beaks. In an episode of this social foraging we noted:

One group of thre birds feeding in the same hole and two others feeding close together, but separate. A solitary first winter bird joined group of three, making four birds feeding together, but then moved back to its previous position 2–3 m away. A first winter bird from group of three moved to join a solitary bird, then returned. At 15:15, the two solitary birds joined together and fed, without any sign of aggression.

(5) There was general tolerance of first winter birds. We saw first winter birds walking up to an adult and the adult walking away, leaving the excavated hole to the newcomer. Our initial thought was that this was a family group. However, one of the same first winter birds subsequently approached three different adults, and the adults walked away. This suggested that tolerance of first winter birds was not confined to other members of a family group. In contrast, we did not record first winter birds walking away when approached by an adult while both were searching for invertebrates.

DISCUSSION

Opportunistic feeding

There were few observations of feeding events on bird and mammal carcasses. We think it is unlikely that we missed other dead pinniped or cetacean feeding events near the Steinhardt station, but given the speed with which the Upland Goose was consumed, we could not say the same of other bird carcasses. Nevertheless, the fact that we saw only three events in a 4–week period suggested that late winter was a time of food shortage on the uninhabited islands where most breeding pairs are found. Rexer–Huber and Bildstein (2012) noted that Striated Caracaras on Saunders Island in winter had lost an average 14% of their summer body mass. Apart from occasional and probably infrequent supplies of carrion, soil invertebrates could be an important means of subsistence for this species in winter on uninhabited islands.

Observations at the Upland Goose kill site and at banding sites were consistent with a "feeding frenzy" for red meat; the greater the previous shortage of food, presumably, the greater the desperation to secure a share. Initial observations at the sea lion carcass supported this view. By the afternoon of the second day at the sea lion carcass, however, although 50 birds were present, the previous intense struggle for food was no longer evident. The "feeding frenzy" lasted no longer than the time taken to get a reasonably full crop.

The loud calling on first locating a new food source of avian or mammalian meat merits comment. A similar behaviour has been reported among common ravens (*Corvus corax*, Heinrich 1989). If the bird is food stressed, why attract others by calling? It is likely that calling serves as a predator detection adaption: a single Striated Caracara at a food source might be vulnerable to predation by a Variable Hawk or Peregrine Falcon (*Falco peregrinus*), but when caracaras are present in numbers these species present less threat. The dead sea lion appeared to be within the territory of an un–banded adult pair of Striated Caracaras. They charged aggressively at some intruding birds, but were unable to chase away a group of nearly 50 individuals.

Tussac peat raking

Whereas Striated Caracaras raking for subsoil invertebrates had been recorded (Woods 2007b) it had not previously received detailed attention. We commonly observed 50 or more birds feeding on the largest raked area in the first two weeks of our visit. By the third and fourth weeks, the numbers were lower, possibly because the dead sea lion and returning albatrosses provided more attractive alternatives. The non–aggressive social foraging for soil invertebrates described here did not involve cooperative searching. It was closer to independent convergence on prey (Ellis *et al*. 1993). Nevertheless, it could have had four advantages for Striated Caracaras. First, it could have reduced the risk of predation, without the need to expend energy on raucous calling and the subsequent feeding frenzy when a new source of red meat is discovered. Second, social foraging created an area largely free of vegetation, thus avoiding expenditure of energy removing surface ground cover. Third, subsoil invertebrates and worms may have had a lower food value than red meat; consequently, it would have been unprofitable to waste energy competing for them. Fourth, searching for invertebrates in fluid, social groups could have conferred some social advantage by strengthening pair bonds and/or family groupings, and there is obvious survival value in adults showing their offspring how to

uncover and capture invertebrates from Tussac peat.

The relative infrequency of other prey and the numbers of Striated Caracaras observed searching for soil invertebrates suggests that these form an important part of their winter diet on uninhabited islands. It is less clear why we saw large numbers of birds searching for invertebrates inland, but much smaller numbers on the shore where invertebrates are plentiful in rotting kelp. This was consistent with Rexer–Huber and Bildstein's (2012) study of Striated Caracaras' winter diet on Saunders Island. They identified three species of marine mollusks, but these were found in only 6.0 to 7.5% of the 67 pellets examined. We suggest four reasons for the much larger number of birds raking the Tussac subsoil rather than rotting kelp. First, the few adult pairs we observed holding coastal territories may have discouraged intruding birds. Second, Striated Caracaras may simply have preferred soil to littoral invertebrates. Third, Striated Caracaras on the shore might have been more vulnerable to predation from Variable Hawks, Peregrine Falcons, or other Striated Caracaras. Whereas they would have been easily visible anywhere on the island, there were few beaches on Steeple Jason where more than a few could feed at the same time. On the inland raking areas the larger numbers might have provided some protection against predation, as suggested above. Fourth, peat invertebrates (including beetle larvae and earthworms) might have been a richer source of nutrients than sand hoppers on beaches or dipteran fly larvae in rotting kelp.

The generally non–aggressive nature of caracaras' interactions with one another while raking the peat for invertebrates contrasts with their behaviour at meat sources. When feeding on meat –for example, the dead sea lion, dead geese, or on the mutton bait at trapping stations– birds of all ages appeared to compete on more or less equal terms. We were not able to discern whether adults were more successful in gaining access to food in these situations, though one newly arrived adult at a "feeding frenzy" seemed briefly to intimidate immature birds. When raking for invertebrates, the overall impression was of harmony, rather than territorial or other intra–specific competition. Our observations of raking birds did not show that adults were more successful than sub–adults or first winter birds in obtaining food, but it seems probable that first year birds are more vulnerable to the effects of food stress in winter. We found nine dead Striated Caracaras during our four weeks on the island; it may not be coincidental that all appeared to be young birds, though their condition did not enable us to distinguish reliably between first winter and sub–adult birds. Food stress could also induce young birds to leave the island to attempt to find food elsewhere.

Whereas our initial observations supported the idea of a free–for–all "feeding frenzy" when avian or mammalian meat was available, it is important to add two qualifications. First, perhaps unsurprisingly, the feeding frenzy lessened when birds were satiated; we noted that within a few minutes of opening the session, only a few individuals maintained frantic activity, with signs of aggression and constant raucous calling. Second, with over 20 Striated Caracaras still present at a banding session, we recorded all episodes of aggressive behaviour in two observations, each of 6 min. We defined 'aggressive behaviour' as 'running head forward towards another bird in an apparent attempt to displace it and/or fighting with another Striated Caracara'. In the first period, the same first winter bird was responsible for ten of 13 episodes and all five episodes in the second. The impression of raucous activity at a food source may be attributable to a disproportionately small number of aggressive birds.

ACKNOWLEDGEMENTS.- This work was partly–funded by Darwin Initiative Grant 19030: Falkland Island Raptors – Reducing Conflicts with Rural Livelihoods. Graham Harris and the Wildlife Conservation Society granted permission to stay in the Steinhardt Field Station on Steeple Jason. Rob McGill and Michael Clarke provided essential logistical support. Hawk Mountain Sanctuary's Director of Conservation Science, Keith Bildstein, directed the banding program and permitted use of relevant data. We received assistance and advice, particularly in the section on opportunistic feeding on avian or mammalian prey, from the Royal Society for the Protection of Birds team investigating aspects of mouse winter biology led by Kalinka Rexer–Huber with support from Graham Parker, Micky Reeves, and Andy Stanworth. Professor Peter Tymms, former Director of Durham University's Centre for Evaluation and Monitoring, carried out the statistical analyses. Map data © 2017 United States www.google.co.uk/maps. We are particularly grateful for an exemplary refereeing process; detailed and constructive criticisms from Dr. Jaime Jiménez, and Dr. Jim Berdnarz, and Dr. Joan Morrison helped us to improve the paper.

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